Kinetic picture of the energy conversion mechanism of collisionless driven reconnection in the presence of a high guide field

S. Inoue¹, Y. Ono¹, R. Horiuchi³, C. Z. Cheng³, Y. Kaminou², X. Guo¹

¹ University of Tokyo, Tokyo, Japan
² National Institute for Fusion Science, Toki, Japan
³ National Cheng Kung University, Tainan, Taiwan

Energy transfer mechanism of the collisionless magnetic reconnection in the presence of a high guide field is studied by the 2D full PIC simulation. We found a new in-plane electric field calculated from the vector potential in the coulomb gauge and a 3D scalar potential is proposed to explain the energy transfer process both of ions and electrons. Electrons gain energy from the scalar potential originated from the reconnection electric field through the field-aligned motion as shown in Figure (a), forming quadrupole profiles of electrostatic potential. This quadrupole structure of the electrostatic potential is experimentally verified in the TS-4 experiment as shown in Figure (b). Strong repulsion force of the electrostatic potential changes motion of ions drastically, causing energy gain from the potential originated from the in-plane electric field. The physical origin of the sequence of energy transfer process is a field-aligned motion of electrons and ions, indicating that the Hall-MHD regime is not sufficient to describe the high guide field collisionless reconnection. The scalar potentials originated from the reconnection electric field and the new in-plane electric field will be presented in detail.

Figure (a) PIC simulation results of field lines and color contour of ES potential and (b) 2D color map of floating potential in the TS-4 tokamak merging experiment.